FIG. 1

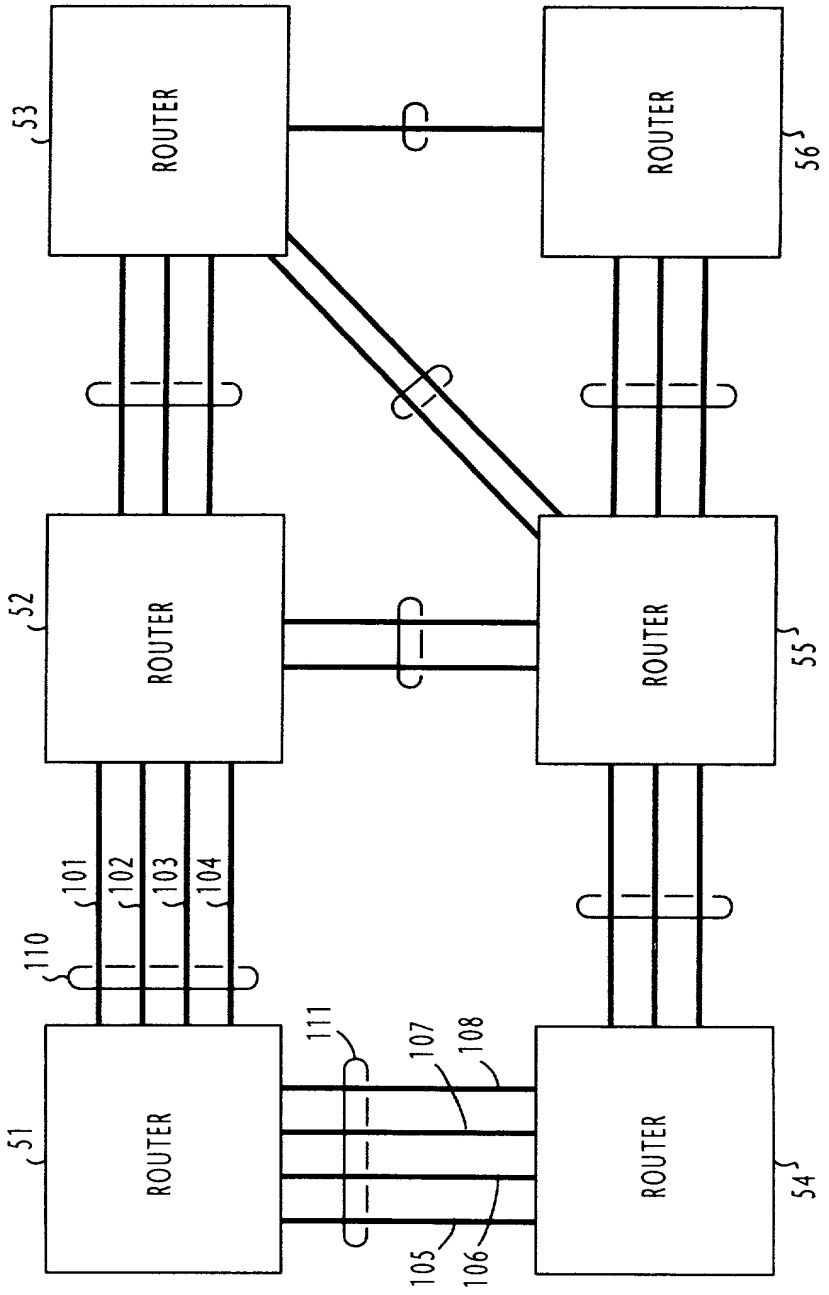
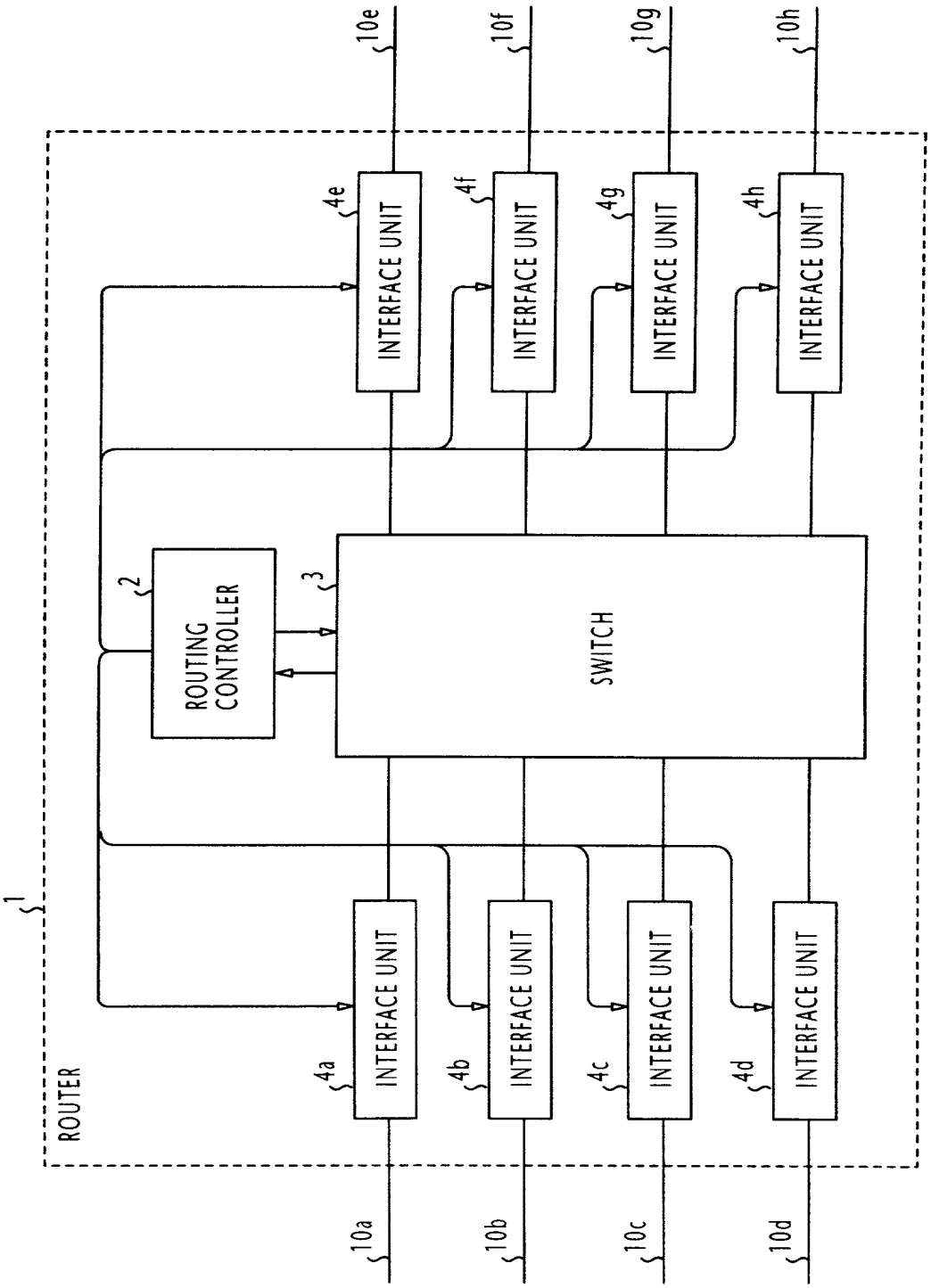

ROUTER
53
ROUTER
56
ROUTER
52
ROUTER
55
101
102
103
104
110
111
107
108
ROUTER
51
ROUTER
54
105
106

FIG. 2


ROUTER
1
ROUTING CONTROLLER
2
SWITCH
3
INTERFACE UNIT
4a
4b
4c
4d
4e
4f
4g
4h
10a
10b
10c
10d
10e
10f
10g
10h

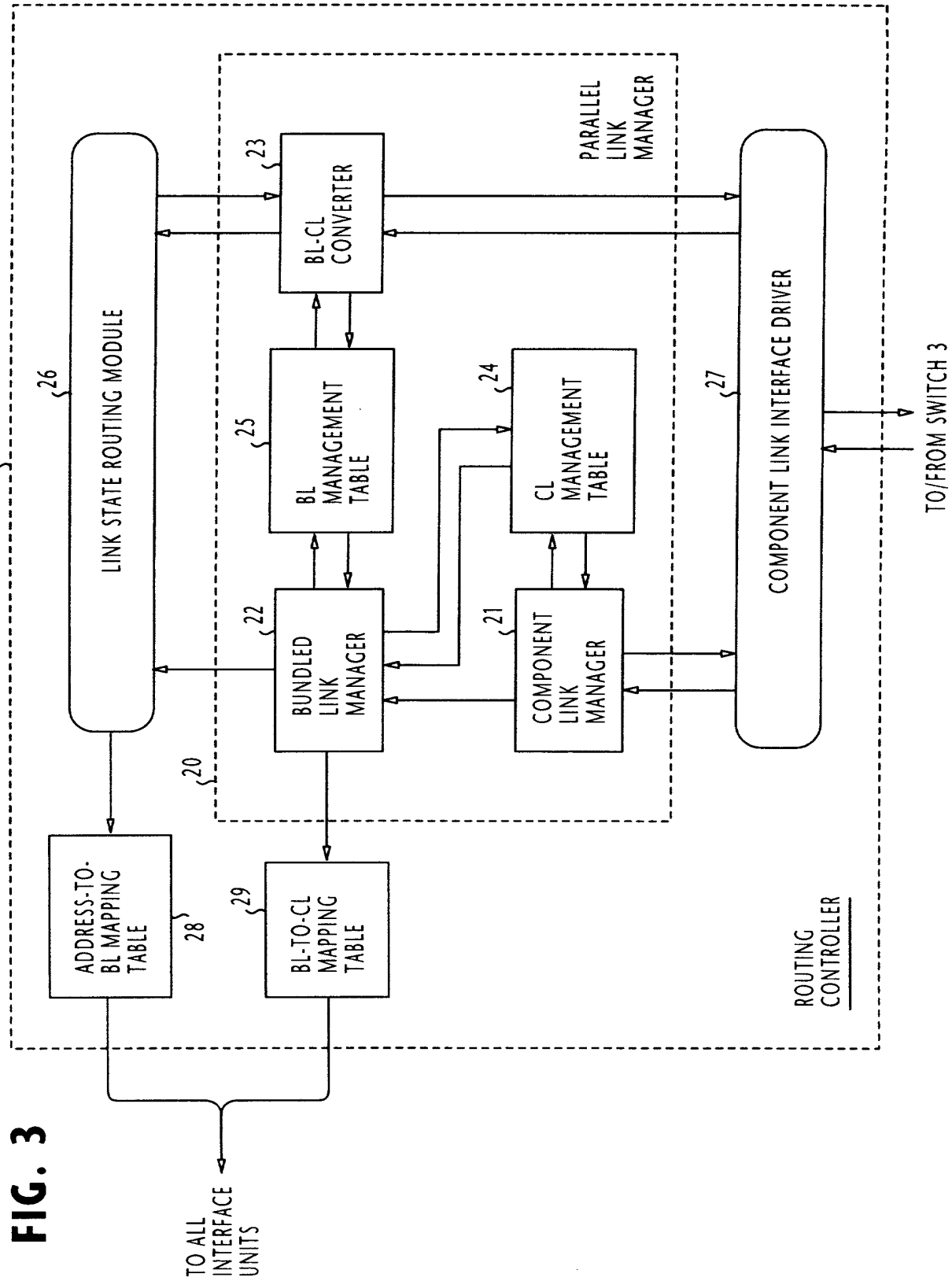

2
LINK STATE ROUTING MODULE
26
PARALLEL LINK MANAGER
BL-CL CONVERTER
23
BL MANAGEMENT TABLE
25
CL MANAGEMENT TABLE
24
BUNDLED LINK MANAGER
22
COMPONENT LINK MANAGER
21
20
COMPONENT LINK INTERFACE DRIVER
27
TO/FROM SWITCH 3
ADDRESS-TO-BL MAPPING TABLE
28
BL-TO-CL MAPPING TABLE
29
TO ALL INTERFACE UNITS
ROUTING CONTROLLER

FIG. 3

Patent Pending

FIG. 4

CL MANAGEMENT TABLE 24

	24-1	24-2	24-3	24-4
COMPONENT LINK ID (CLID)	COMPONENT LINK STATE (CLST)	NEIGHBOR ROUTER ID (NRID)	NEIGHBOR ROUTER LINK ID (NCLID)	COMP. LINK BANDWIDTH (CLBW)
CLID=1	ESTABLISHED	133.206.0.2	NCLID=2	10
CLID=2	ESTABLISHED	133.206.0.2	NCLID=3	10
CLID=3	ESTABLISHED	133.206.0.2	NCLID=4	10
CLID=4	ESTABLISHED	133.206.0.3	NCLID=1	20
CLID=5	ESTABLISHED	133.206.0.3	NCLID=2	20
CLID=6	UP	133.206.0.3	NCLID=3	20
CLID=7	UP	—	—	10
CLID=8	UP	—	—	10
CLID=9	DOWN	—	—	30
CLID=10	DOWN	—	—	30

FIG. 5

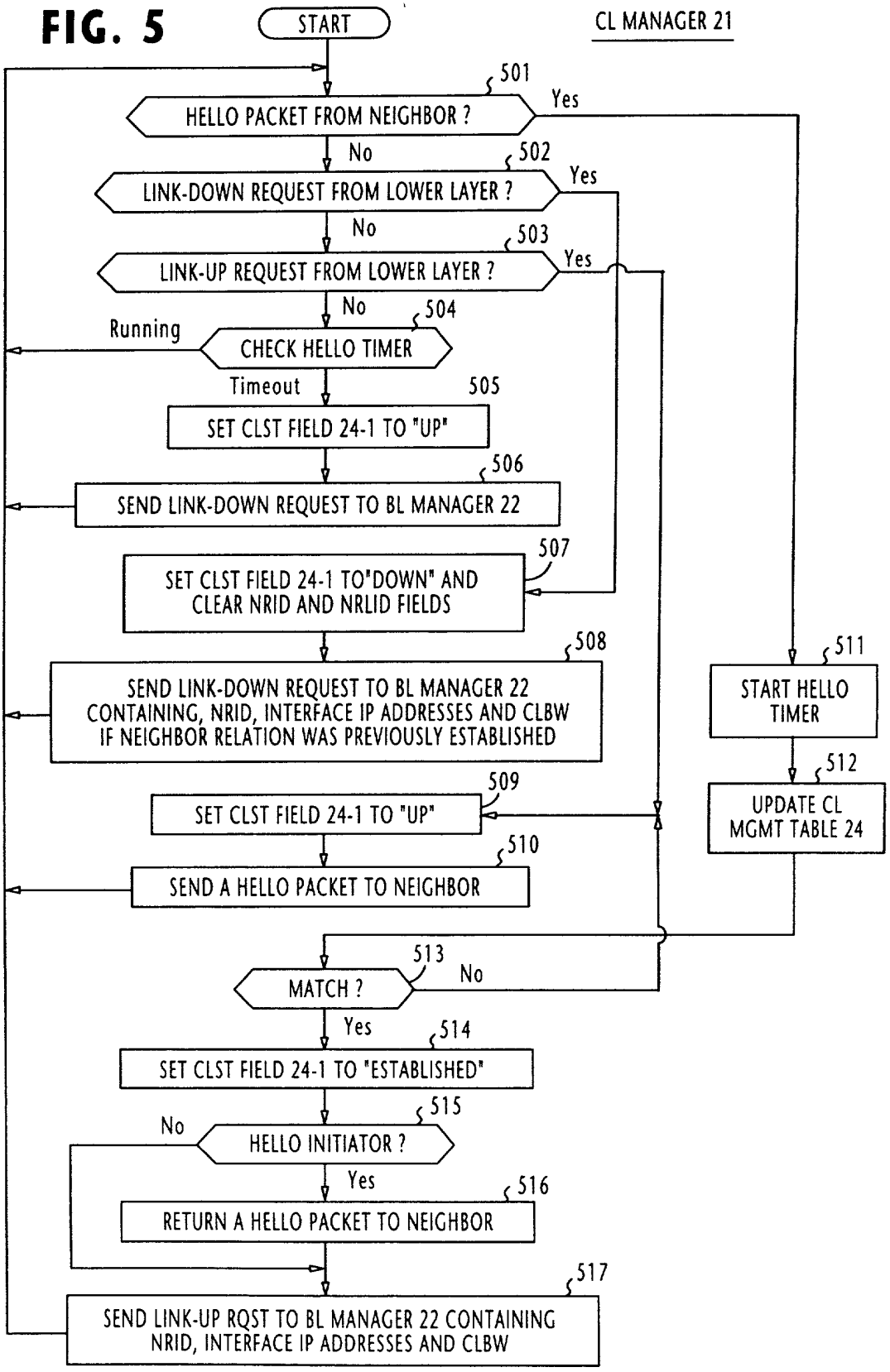
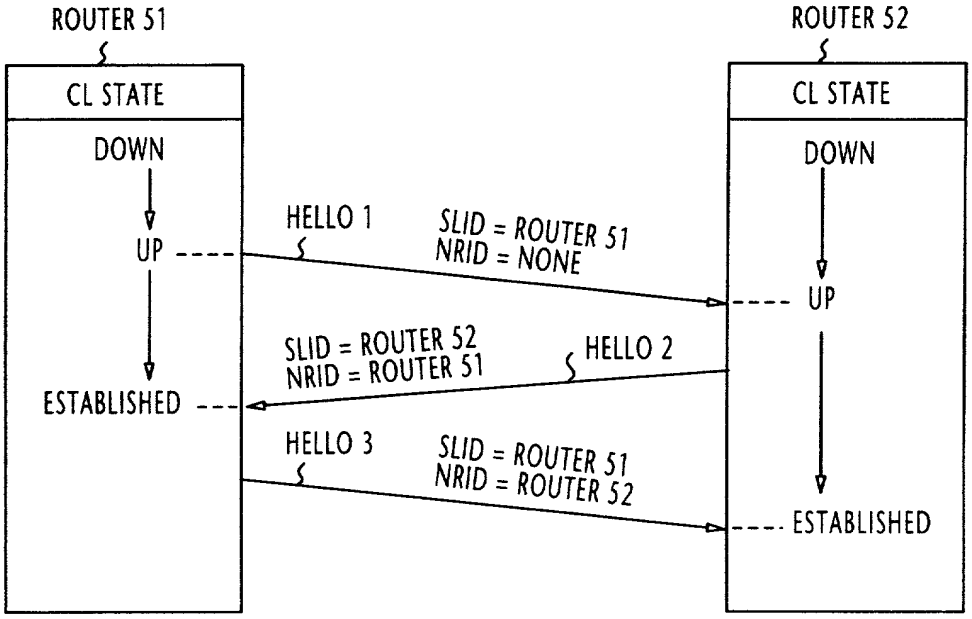

START
CL MANAGER 21
501
HELLO PACKET FROM NEIGHBOR ?
Yes
No
502
LINK-DOWN REQUEST FROM LOWER LAYER ?
Yes
No
503
LINK-UP REQUEST FROM LOWER LAYER ?
Yes
No
504
Running
CHECK HELLO TIMER
Timeout
505
SET CLST FIELD 24-1 TO "UP"
506
SEND LINK-DOWN REQUEST TO BL MANAGER 22
507
SET CLST FIELD 24-1 TO"DOWN" AND CLEAR NRID AND NRLID FIELDS
508
SEND LINK-DOWN REQUEST TO BL MANAGER 22 CONTAINING, NRID, INTERFACE IP ADDRESSES AND CLBW IF NEIGHBOR RELATION WAS PREVIOUSLY ESTABLISHED
509
SET CLST FIELD 24-1 TO "UP"
510
SEND A HELLO PACKET TO NEIGHBOR
511
START HELLO TIMER
512
UPDATE CL MGMT TABLE 24
513
MATCH ?
No
Yes
514
SET CLST FIELD 24-1 TO "ESTABLISHED"
515
No
HELLO INITIATOR ?
Yes
516
RETURN A HELLO PACKET TO NEIGHBOR
517
SEND LINK-UP RQST TO BL MANAGER 22 CONTAINING NRID, INTERFACE IP ADDRESSES AND CLBW

FIG. 6


ROUTER 51
CL STATE
DOWN
UP
ESTABLISHED
HELLO 1
SLID = ROUTER 51
NRID = NONE
SLID = ROUTER 52
NRID = ROUTER 51
HELLO 2
HELLO 3
SLID = ROUTER 51
NRID = ROUTER 52
ROUTER 52
CL STATE
DOWN
UP
ESTABLISHED

TOSHIBA DESIGN

FIG. 7

BL MANAGEMENT TABLE 25

BUNDLED LINK IDENTIFIER (BLID) (25-1)	NEIGHBOR ROUTER ID (NRID) (25-2)	BUNDLED LINK STATE (BLST) (25-3)	NUMBER OF COMP. LINKS (CLN) (25-4)	LOCAL INTERFACE IP ADDRESS (25-5)	NEIGHBOR INTERFACE IP ADDRESS (25-6)	TOTAL (BL) BANDWIDTH (BLBW)
11	133.206.0.2	UP	3	133.206.10.1	133.206.10.2	30
12	133.206.0.3	UP	2	UNNUMBERED	UNNUMBERED	40
13	133.206.0.4	DOWN	0	133.206.30.1	133.206.30.4	0

FIG. 8

BL-TO-CL MAPPING TABLE 29

BUNDLED LINKS	BLID=11	COMP. LINKS	CLID=1	CLID=2	CLID=3	—	—
		USAGE RATIO	R1	R2	R3	—	—
	BLID=12	COMP. LINKS	CLID=4	CLID=5	—	—	—
		USAGE RATIO	R4	R5	—	—	—

FIG. 9

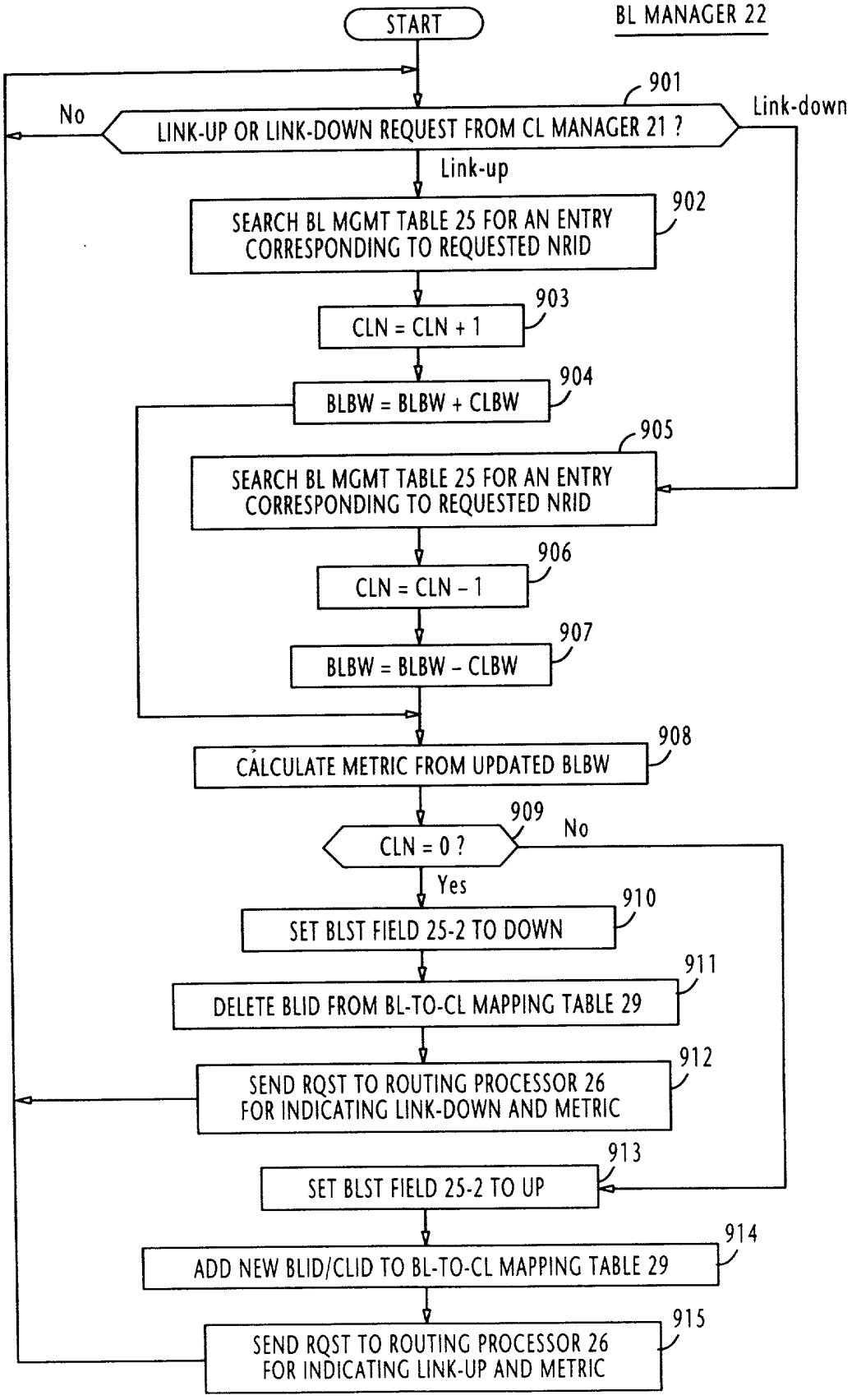
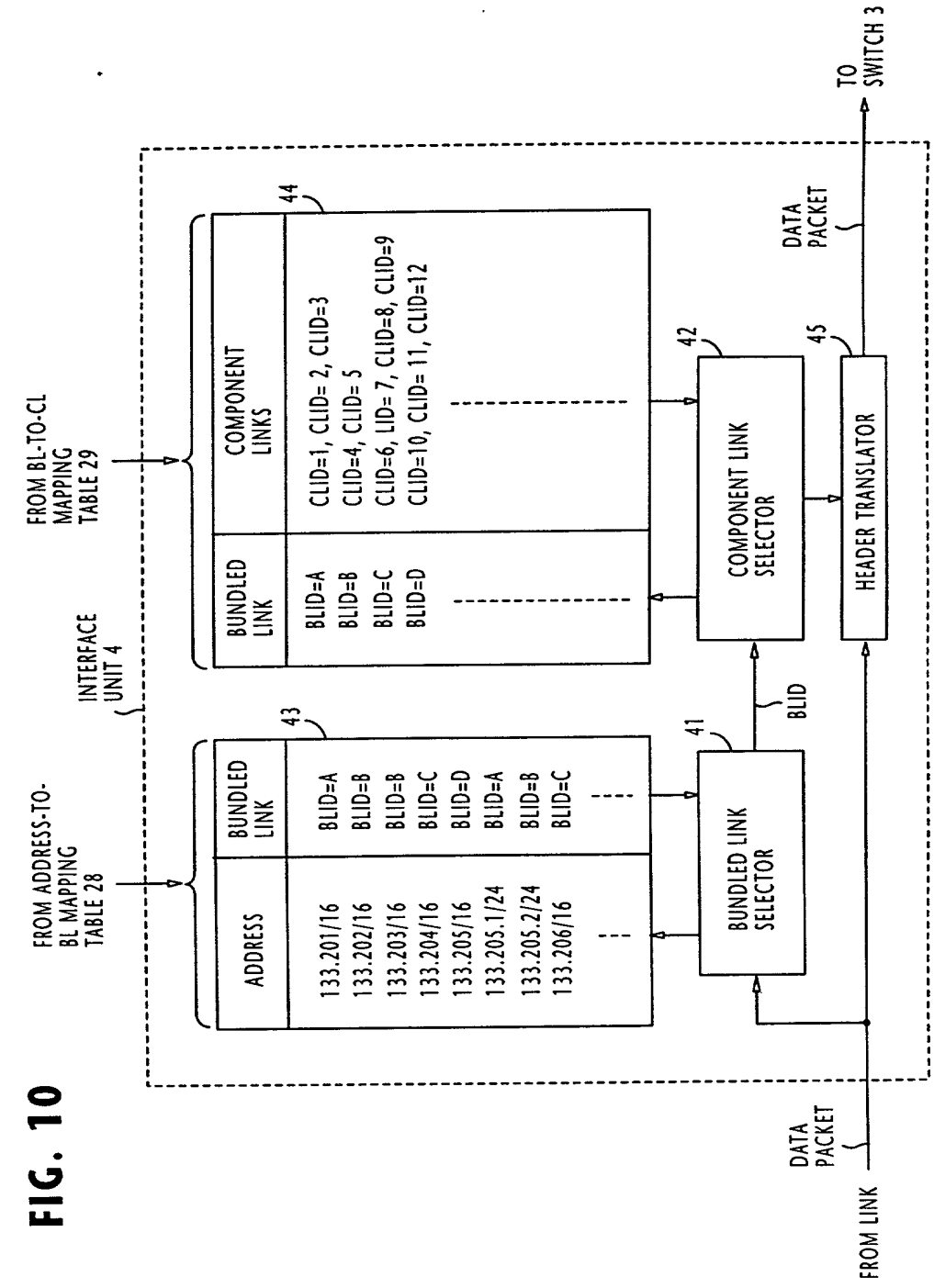

START
BL MANAGER 22
901
No
LINK-UP OR LINK-DOWN REQUEST FROM CL MANAGER 21 ?
Link-down
Link-up
902
SEARCH BL MGMT TABLE 25 FOR AN ENTRY CORRESPONDING TO REQUESTED NRID
903
CLN = CLN + 1
904
BLBW = BLBW + CLBW
905
SEARCH BL MGMT TABLE 25 FOR AN ENTRY CORRESPONDING TO REQUESTED NRID
906
CLN = CLN - 1
907
BLBW = BLBW - CLBW
908
CALCULATE METRIC FROM UPDATED BLBW
909
CLN = 0 ?
No
Yes
910
SET BLST FIELD 25-2 TO DOWN
911
DELETE BLID FROM BL-TO-CL MAPPING TABLE 29
912
SEND RQST TO ROUTING PROCESSOR 26 FOR INDICATING LINK-DOWN AND METRIC
913
SET BLST FIELD 25-2 TO UP
914
ADD NEW BLID/CLID TO BL-TO-CL MAPPING TABLE 29
915
SEND RQST TO ROUTING PROCESSOR 26 FOR INDICATING LINK-UP AND METRIC

FIG. 10


FROM ADDRESS-TO-BL MAPPING TABLE 28
INTERFACE UNIT 4
FROM BL-TO-CL MAPPING TABLE 29
ADDRESS
BUNDLED LINK
43
133.201/16 BLID=A
133.202/16 BLID=B
133.203/16 BLID=B
133.204/16 BLID=C
133.205/16 BLID=D
133.205.1/24 BLID=A
133.205.2/24 BLID=B
133.206/16 BLID=C
BUNDLED LINK
COMPONENT LINKS
44
BLID=A CLID=1, CLID= 2, CLID=3
BLID=B CLID=4, CLID= 5
BLID=C CLID=6, LID= 7, CLID=8, CLID=9
BLID=D CLID=10, CLID= 11, CLID=12
41
BUNDLED LINK SELECTOR
BLID
42
COMPONENT LINK SELECTOR
45
HEADER TRANSLATOR
DATA PACKET
TO SWITCH 3
DATA PACKET
FROM LINK

PATENT-BASED

FIG. 11

BL MANAGEMENT TABLE 25

BUNDLED LINK IDENTIFIER (BLID) 25-1	NEIGHBOR ROUTER ID (NRID) 25-2	BUNDLED LINK STATE (BLST) 25-3	NUMBER OF COMP. LINKS (CLN) 25-4	LOCAL INTERFACE IP ADDRESS 25-5	NEIGHBOR INTERFACE IP ADDRESS 25-6	TOTAL BANDWIDTH (BLBW) 25-7	COMP. LINK BANDWIDTH (CLBW)
11	133.206.0.2	UP	3	133.206.10.1	133.206.10.2	30	10
12	133.206.0.3	UP	2	UNNUMBERED	UNNUMBERED	40	20
13	133.206.0.4	DOWN	0	133.206.30.1	133.206.30.4	0	0

Patent Application

FIG. 12

BL MANAGEMENT TABLE 25

25-1 BUNDLED LINK IDENTIFIER (BLID)	NEIGHBOR ROUTER ID (NRID)	25-2 BUNDLED LINK STATE (BLST)	25-3 NUMBER OF COMP. LINKS (CLN)	25-4 LOCAL INTERFACE IP ADDRESS	25-5 NEIGHBOR INTERFACE IP ADDRESS	25-6 TOTAL BANDWIDTH (BLBW)	25-7 COMP. LINK BANDWIDTH (CLBW)
11	133.206.0.2	UP	3	133.206.10.1	133.206.10.2	30	10
12	133.206.0.3	DOWN	0	133.206.20.1	UNNUMBERED	0	0

⇩

25-1 BUNDLED LINK IDENTIFIER (BLID)	NEIGHBOR ROUTER ID (NRID)	25-2 BUNDLED LINK STATE (BLST)	25-3 NUMBER OF COMP. LINKS (CLN)	25-4 LOCAL INTERFACE IP ADDRESS	25-5 NEIGHBOR INTERFACE IP ADDRESS	25-6 TOTAL BANDWIDTH (BLBW)	25-7 COMP. LINK BANDWIDTH (CLBW)
11	133.206.0.2	UP	3	133.206.10.1	133.206.10.2	30	10
12	133.206.0.3	UP	1	133.206.20.1	133.206.10.3	40	40

FIG. 13

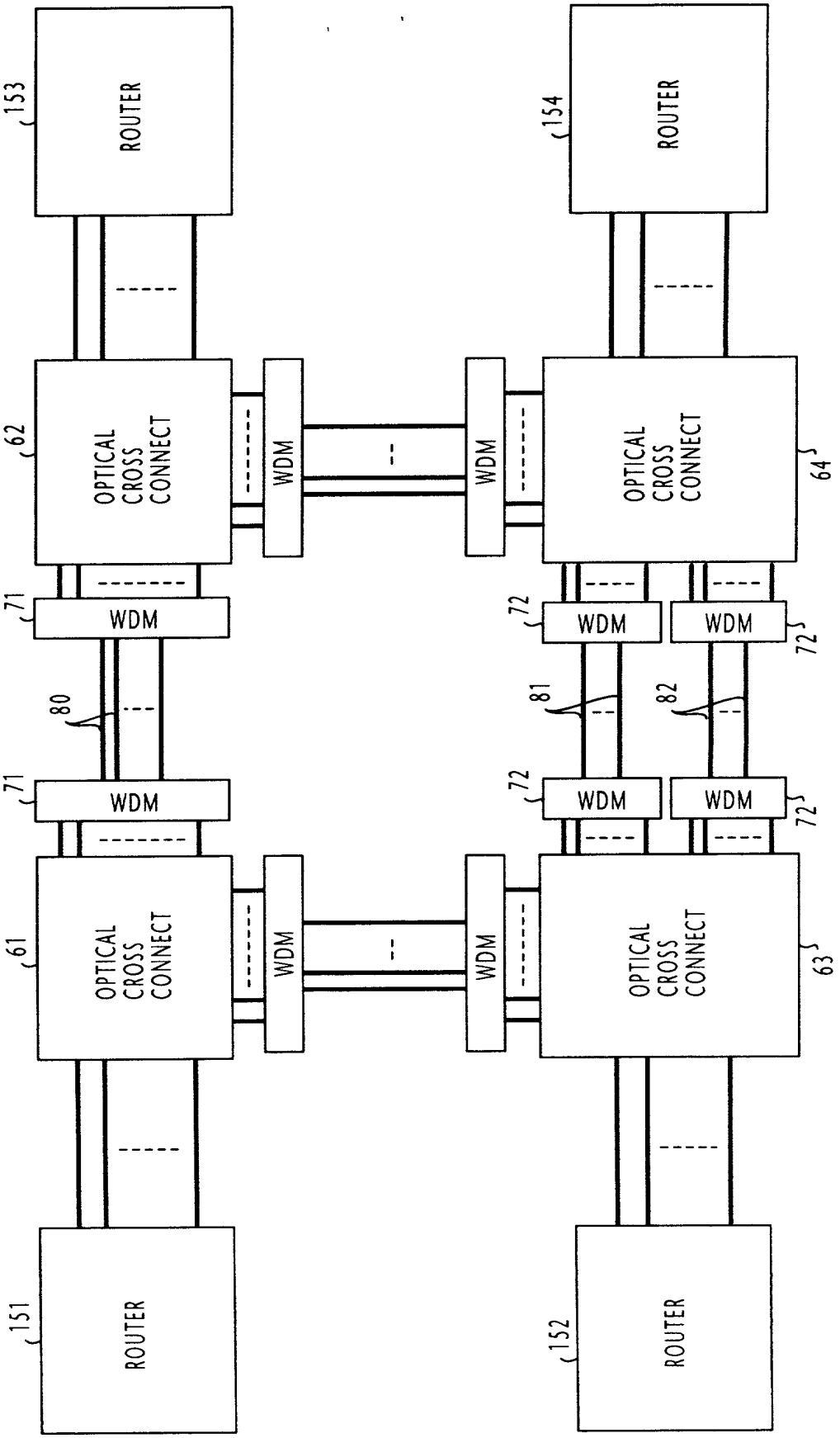

153
ROUTER
154
ROUTER
62
OPTICAL CROSS CONNECT
WDM
WDM
OPTICAL CROSS CONNECT
64
71
WDM
72
WDM
WDM
72
80
81
82
71
WDM
72
WDM
WDM
72
61
OPTICAL CROSS CONNECT
WDM
WDM
OPTICAL CROSS CONNECT
63
151
ROUTER
152
ROUTER

FIG. 14

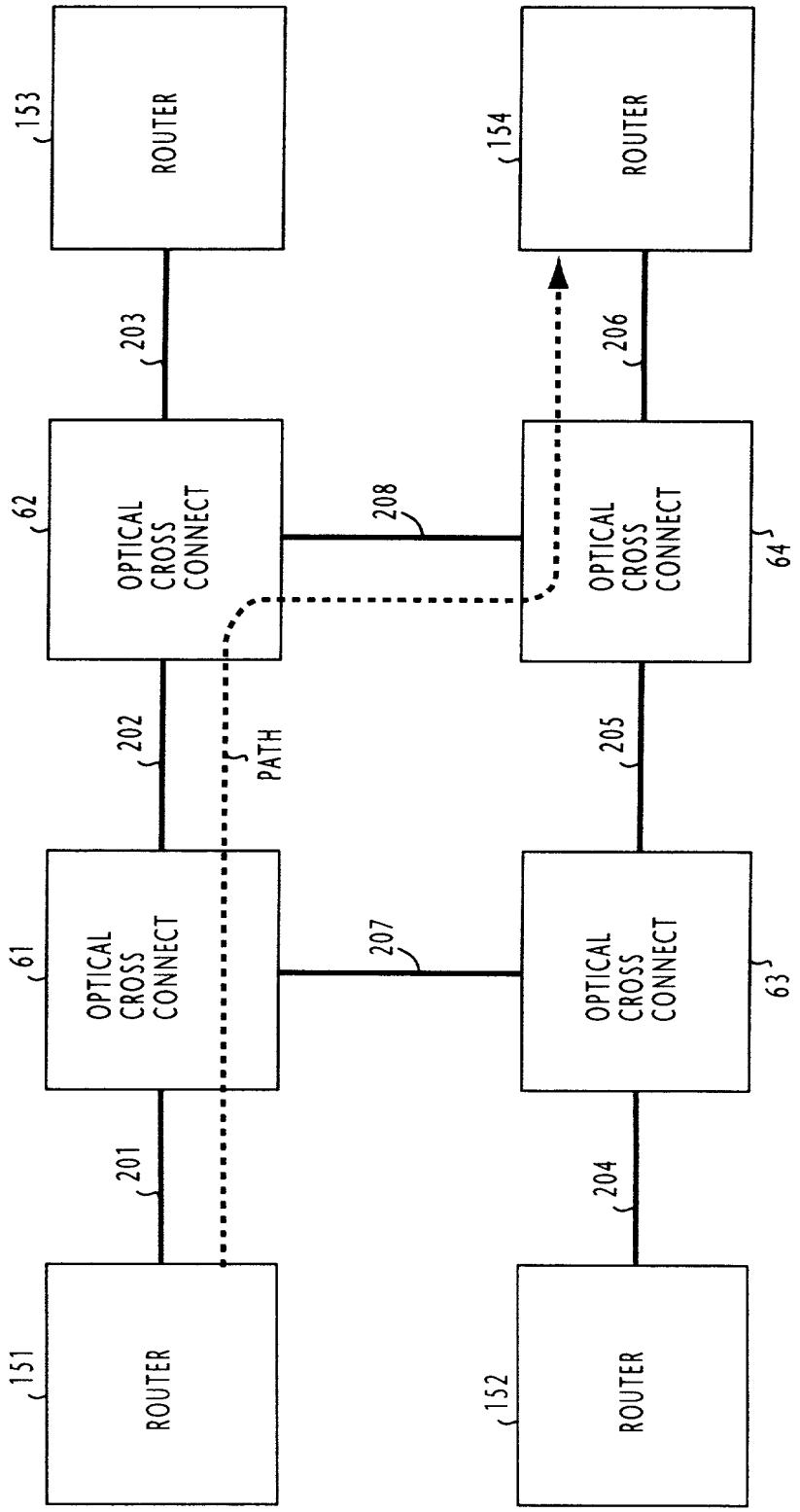

153
ROUTER
154
ROUTER
203
206
62
OPTICAL CROSS CONNECT
208
OPTICAL CROSS CONNECT
64
202
PATH
205
61
OPTICAL CROSS CONNECT
207
OPTICAL CROSS CONNECT
63
201
204
151
ROUTER
152
ROUTER

FIG. 15 CL MANAGEMENT TABLE 24A

COMPONENT LINK ID (CLID)	COMPONENT LINK STATE (CLST)	NEIGHBOR ROUTER ID (NRID)	NEIGHBOR ROUTER LINK ID (NCLID)	COMP. LINK BANDWIDTH (CLBW)	BUSY/IDLE FLAG
CLID=1	ESTABLISHED	133.206.0.2	NCLID=2	10	B/I
CLID=2	ESTABLISHED	133.206.0.2	NCLID=3	10	B/I
CLID=3	UP	133.206.0.2	NCLID=4	10	B/I
CLID=4	DOWN	133.206.0.3	NCLID=1	20	B/I
CLID=5	DOWN	133.206.0.3	NCLID=2	20	B/I

FIG. 16 BL MANAGEMENT TABLE 25A

BUNDLED LINK IDENTIFIER (BLID)	NEIGHBOR ROUTER ID (NRID)	BUNDLED LINK STATE (BLST)	NUMBER OF IDLE COMPONENT LINKS (ILN)	NUMBER OF COMPONENT LINKS (CLN)	LOCAL INTERFACE IP ADDRESS	NEIGHBOR INTERFACE IP ADDRESS
11	133.206.0.1	UP	1	3	133.206.40.1	133.206.40.1
12	133.206.0.3	UP	1	3	133.206.30.2	133.206.30.3

FIG. 17

OPTICAL CROSS-CONNECT (OXC) NODE

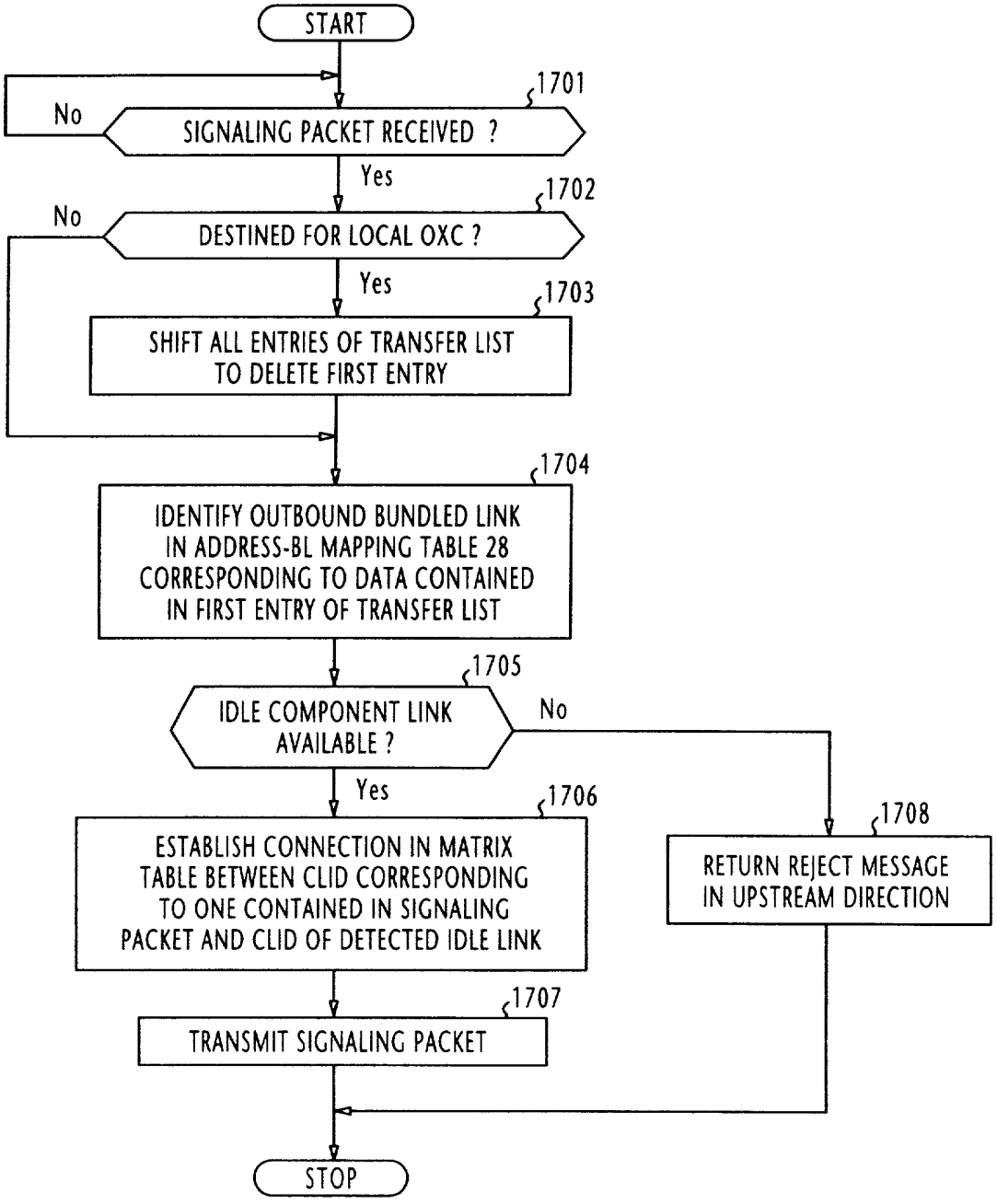


FIG. 18A

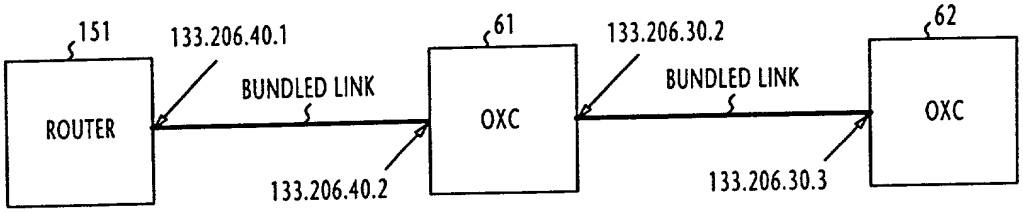
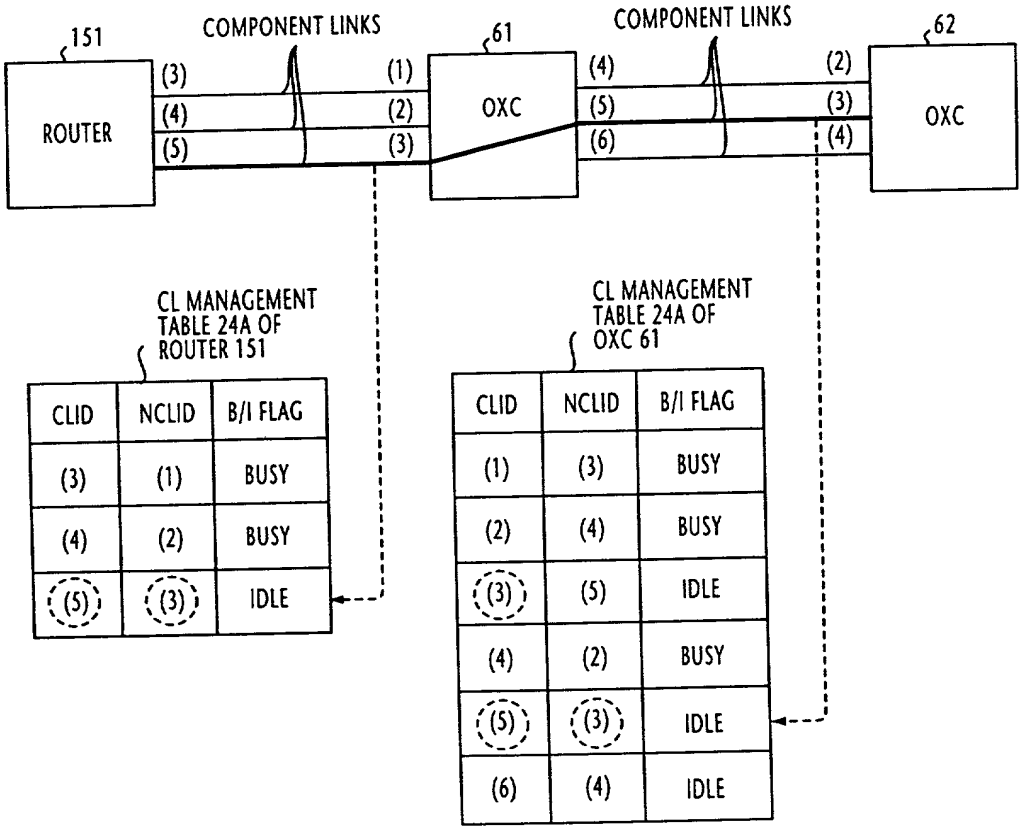


FIG. 18B



CLID	NCLID	B/I FLAG
(3)	(1)	BUSY
(4)	(2)	BUSY
(5)	(3)	IDLE

CLID	NCLID	B/I FLAG
(1)	(3)	BUSY
(2)	(4)	BUSY
(3)	(5)	IDLE
(4)	(2)	BUSY
(5)	(3)	IDLE
(6)	(4)	IDLE